M.C.A.P. 102

MINISTRY OF CIVIL AVIATION

CIVIL AIRCRAFT ACCIDENT

Report of the Court Investigation on the Accident to Dakota EI-AFL on 10th January, 1952

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To the Right Honourable [redacted] *M.P.*,
Minister of Civil Aviation.

SIR,

I have the honour to send to you herewith my Report in the matter of the tragic accident which befell the Irish Air Liner " Saint Kevin " in Caernarvonshire last January.

The documents and other exhibits which were before the Court and the transcript of the shorthand note of the proceedings have been handed back to your Accidents Branch and are no doubt available for your perusal or examination within your Ministry. The formal instruments constituting the Court and appointing the Assessors are set out *in extenso* in the transcript and I see no advantage in referring further to them here.

The Report I now send you is, I am happy to say, unanimous. Indeed at no time was there any hint of disagreement between my Assessors or between either of them and myself.

I was glad to find that the " Questions " which the new Regulations require to be formulated by the Attorney-General did in fact prove to be useful in just the way I had suggested in my letter to Lord [redacted] dated the 27th April, 1951.

It is my duty to inform you that learned Counsel for the Operators in this case strongly urged upon the Court that it was desirable that its findings should be pronounced in open Court and that such pronouncement should come before any opportunity is given for departmental or inter-departmental discussion of the findings. Having regard to the terms of paragraph 9 (18) of the Regulations I must leave the matter in your hands saying only that I am willing to sit again for the purpose of announcing our findings if you so desire it.

Since a tragedy is the whole occasion of these Inquiries I think it well to point to the good that can flow even from so painful a tragedy as this was. The good in this case was the opportunity it afforded for a large number of Irish and British individuals to become acquainted and to work together in the common cause of guarding against the occurrence of similar tragedies in the future.

I was greatly impressed and touched by the warmth of friendliness which our Irish neighbours brought with them to London and in to the Court Room. I hope you will take the opportunity of reading what Mr. [redacted] said at the close of the Inquiry : it seems to me to be a model of the felicitous.

It is to you also that I prefer to address a few words of appreciation of what Aer Lingus have done in collaboration with the owner of the land upon which the crash occurred to make the place in which most of the bodies remain a worthy resting place. You may read in the transcript of the proceedings a description of what will be done to clothe the place with consolation.

I must turn now to what is for me the pleasantest part of this letter ; a mention of my Assessors.

Mr. [redacted] C.B., D.S.O., O.B.E., F.R.S., is a colleague of such distinction as a scientist that I need say no word of praise but should say many words of thanks. His hand will be readily recognised in many passages of the Report.

Captain [redacted], O.B.E., who has to his credit the awesome total of over 13,000 flying hours adds to that achievement so charming a modesty that it would probably embarrass him if I were to say more than " thank you." So that is all I will say.

But one thing more.

In my letter to [redacted] to which I have referred I gave a strong hint that something practical ought to be done to recognise that the work of the Assessors is only half done when the Public Hearings come to an end. Yet their remuneration comes to an end then. My present Assessors gave up no fewer than nine more days to work with me on the Report. I really think something ought to be done.

I have the honour to be,

Sir,

Your obedient Servant,

[redacted]

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THE CIVIL AVIATION ACT 1949

THE CIVIL AVIATION (INVESTIGATION OF ACCIDENTS) REGULATIONS 1951

Report of the Public Inquiry into the causes and circumstances of the accident which occurred on the 10th January, 1952, to the Dakota aircraft EI-AFL.

AIRCRAFT : Dakota EI-AFL (" Saint Kevin ") ENGINES : Two Pratt and Whitney Twin Wasp

REGISTERED OWNERS AND OPERATORS : Aer Lingus Teoranta

CREW : Captain [redacted]—Killed.
First Officer [redacted]—Killed.
Stewardess [redacted]—Killed.

PASSENGERS : 20—All Killed.

PLACE OF ACCIDENT : Near Lake Gwynant, Caernarvonshire, in lat. 53° 2′ 52″ N., long. 3° 59′ 7″ W.

DATE AND TIME : 10th January, 1952, at about 1915 hrs. G.M.T.

Unless otherwise stated all times in this Report are G.M.T., all bearings, courses and wind directions are true and all heights are heights above mean sea level.

INTRODUCTION

1. At 1725 hours on 10th January, 1952, the DC-3 Dakota aircraft EI-AFL commonly known and hereinafter referred to as the " Saint Kevin " and belonging to and operated by Aer Lingus took off from Northolt Airport en route for Dublin. The aircraft was manned by a crew of three, i.e. a Captain, a 1st Officer and a Stewardess, and carried 20 passengers whose names are shown upon the Passenger Manifest. There was a small quantity of cargo on board of no significance to this inquiry. The take-off weight of the aircraft was 11,959 kilogrammes as against an authorised maximum take-off weight of 12,227 kilogrammes.

2. The route chosen by the Captain was by way of Airway Amber One as far as Daventry, thence to Nevin Beacon in the Caernarvonshire peninsula and on to Dublin. It can be safely asserted that the flight was without incident at least as far as Welshpool, which was reached shortly after 1838 hours at which time the " Saint Kevin " reported its expected time of arrival (ETA) over Nevin to be 1910 hours and at Dublin 1951 hours.

3. The intended course from this point onwards until the coast was reached at a point near Harlech lay over the Welsh mountains with heights rising to about 3,000 feet.

4. At 1855 hours the " Saint Kevin ", which throughout was flying under Instrument Flight Rules (IFR), asked and received permission from Preston Air Traffic Control to ascend from 4,500 feet which was the planned height of the flight to 6,500 feet being the next authorised level for westbound flights on this route. No reason was given for this request.

5. At 1858 hours the " Saint Kevin " reported to Preston that it was flying at 6,500 feet and at about 1912 hours that its position was Nevin when Preston instructed the aircraft to go over to the control of Dublin. Almost immediately afterwards an aircraft-to-aircraft conversation took place between the " Saint Kevin " and an eastbound airliner of the same Company flying at 5,500 feet which also reported to Preston its position as being over Nevin at 1912 hours. The " Saint Kevin " had asked Preston for news of any out-bound aircraft from Dublin on the London route and on being told that there was one with registration letters EI-ACI estimated to be at Nevin at 1912 hours called that aircraft using the words "You'll find it pretty rough over the hills tonight, we were at four five, went up to six five, it seems to be right through."

6. At some time between 1912 and 1915 hours the " Saint Kevin " having changed to the Dublin frequency reported " We checked over Nevin a minute ago flying six five IFR. We just

passed EI-ACI request descent clearance please." Dublin acknowledged this request and granted clearance which was not acknowledged by the aircraft. No further radio message from the "Saint Kevin" was received by Dublin or any other station.

7. In fact the "Saint Kevin" was neither over nor abeam on her course of Nevin at 1912 hours. At a time probably not later than 1915 hours the aircraft crashed to the ground at a point lat. 53° 2′ 52″ N., long. 3° 59′ 7″ W. approximately 18 nautical miles from Nevin Beacon in a north-easterly direction and 1,200 feet above mean sea level.

8. This point lies about 4 nautical miles distant on a bearing of about ESE. from the summit of Snowdon (3,560 feet).

9. The aircraft was heard, but not seen, from the ground during the last moments of its flight. It is not however possible to extract from the witnesses' descriptions of their auditory sensations any precise idea of how it was behaving. There is, however, some evidence that it was not then holding a straight course.

10. The wind at the time of the crash was, leaving out of account distortions due to orographical features, a head wind, i.e. WNW. of a speed of about 60 knots.

11. All the occupants of the aircraft lost their lives. They must all have been killed outright by the crash and not by the fire which broke out immediately afterwards.

12. The main problems for the Court were to discover (i) why the "Saint Kevin" was so far from the position in which the Captain apparently believed it to be and (ii) what caused it to strike the ground.

Part I

THE AIRCRAFT

13. The "Saint Kevin" was constructed in the United States of America by the Douglas Aircraft Company Inc. in 1944 and was first used by the Royal Air Force. It was then transferred to Scottish Aviation Ltd., who sold it in June, 1950, to Aer Lingus after converting it to civil requirements. It was in regular use on the British and Continental scheduled passenger services of Aer Lingus which is a limited liability company incorporated in Eire. The aircraft had flown a total of 4,339 hours of which 2,343 had been under the flag of Aer Lingus. Such a number of flying hours does not even approach the average life span of comparable aircraft of these and other experienced operators.

14. The engines fitted in the aircraft consisted of two Pratt and Whitney Twin Wasp engines. The flying hours of these engines were well within their approved engine life and in the view of the Court no failure or deficiency of the engines contributed in any way to the disaster.

15. The Certificate of Airworthiness issued by the Irish Department of Industry and Commerce on the 9th June, 1950, was valid until the 9th May, 1952. The "Saint Kevin" underwent the prescribed routine maintenance checks at the proper intervals and the last "check 2" was carried out during the night of 8th/9th January, 1952, at Northolt after which the required Certificate of Safety for Flight was signed by duly licensed Inspectors in respect of both airframe and engines. The validity of this certificate was 48 hours elapsed time, that is to say until 0600 hours on the 11th January. The Court is satisfied that nothing turns upon any question of compliance or non-compliance with any statutory or administrative requirement relating to the maintenance of airworthiness but will revert later on in this Report to an aspect of the topic of maintenance checks which it considers to be of general importance.

16. It is not proposed here to set out details of so well known a type of aircraft except such as might have some bearing upon the accident under investigation. The following information will however be seen to be relevant as this report develops.

(*a*) The aircraft was fitted with an anti-icing system for the propellers. This system consists of an electrically operated pump which draws the anti-icing fluid from a 3½ gallon tank situated behind the left hand (or Captain's) seat and forces it to each individual blade root and thence by centrifugal force along the blades. The capacity of the tank is sufficient to give an endurance of 7 hours at minimum and 1¼ hours at maximum rate of flow.

(*b*) Carburettor anti-icing was secured by (i) the intake of hot air, (ii) the supply of anti-icing fluid by electric pump from a 9 gallon tank situated in No. 1 cargo hold.

(*c*) The pitot heads, which are essential to the functioning of the air speed indicators, the altimeters and the rate of climb indicator, were electrically heated to prevent the deposition of ice upon them.

(*d*) The de-icing equipment consisted of standard Goodrich inflatable rubber "boots" fitted along the leading edges of the main planes, tail planes and fin. The controlling pulsations are induced by air pressure supplied by a vacuum pump attached to each engine. The control switch for this device is situated on the bulkhead behind the right-hand (or 1st Officer's) seat.

This emphasis upon anti-icing and de-icing equipment must not be taken to point to any conclusion that icing played any significant part in the disaster under investigation.

17. The "Saint Kevin" was supplied with adequate equipment giving two-way radio-telephone (R/T) communication on all the appropriate very high frequencies (VHF). It is known that this equipment was working up to the last moments of the flight. Radio Compass, Gee (a navigational device enabling a positional fix to be obtained usually in less than one minute but requiring the full attention of the person operating it during such time) and Standard Beam Approach (SBA) were also fitted. There is no reason to suppose that any one of these latter devices failed to function at any material time.

Part II

THE CREW

18. Captain [redacted] who was in command of the "Saint Kevin" was born on the 2nd November, 1921. His total of flying hours up to the day of the accident amounted to 4,887, of which 3,703 were with Aer Lingus and 3,420 as Captain of DC-3 Aircraft belonging to that Company. Captain [redacted] held Air Line Transport Pilot's Licence No. 29 issued by the Department of Industry and Commerce which was valid until the 30th April, 1952, and Flight Radio Officer's Licence Radio-Telephony (General) No. 43 valid until the 2nd May, 1952. He had duly carried out the prescribed periodic and instrument rating checks at the last of which he was reported upon in highly satisfactory terms. Between the 26th and 28th November he did a total of 4½ hours Link Training and received a satisfactory report.

19. First Officer [redacted] was born on the 27th July, 1921. His total of flying hours up to the day of the accident was 3,779, of which 2,630 were with Aer Lingus mainly as 1st Officer on DC-3 aircraft. He held an Irish Senior Commercial Pilot's Licence No. 3 valid until the 3rd April, 1952. This officer had passed the requisite periodic and instrument rating checks and had been in the Link Trainer on the 21st November, 1951. He did not hold a R/T licence at the date of the accident and there was no evidence that he had at any time held one.

20. The recent rostering of each of the pilots was well within the number of flying hours per month permitted by the agreement between the Operators and the Irish Air Line Pilots' Association, i.e., 85 hours per month during the winter months. On the 10th January both Captain [redacted] and First Officer [redacted] had made one round trip Dublin-Birmingham-Dublin (a total of about 3 flying hours) and one eastbound trip Dublin-Northolt (about 1½ hours) before taking off on the fatal flight.

The Court is unable to conclude that either officer was under any strain reasonably attributable to fatigue on his last flight.

21. The Stewardess [redacted] was a victim of the crash but played no part in the events which led up to it.

Part III

THE GENERAL METEOROLOGICAL SITUATION PRIOR TO AND AT THE TIME OF THE FLIGHT

22. Prior to and at the time of the flight there was a broad, deep and rapid stream of air from the middle of the Atlantic across the whole of Ireland and across England south of a line approximately from Morecambe Bay to the Humber. The direction of the stream was from WNW. to ESE. There was little variation in the direction up to heights of over 30,000 feet but the speed increased from about 60 knots at 6,000 feet to about 100 knots at 30,000 feet.

The air in this stream had come from the Western Atlantic between the Azores and Bermuda. On January 8th and 9th it had moved thence north about 1,500 miles. The lower layers were cooled as they moved over the colder ocean. These layers became very stable, i.e. resistant to vertical motion. In fact at this stage the temperature at 3,000 feet, 50° F., was higher than the temperature at sea-level, about 45° F.

The stream turned gradually eastwards and from longitude 30° W. moved at the great speeds already mentioned parallel to a stream of much colder air to the north of it, between latitudes 55° N. and 65° N. This latter stream was moving

more slowly at heights below 20,000 feet, but at equal or higher speeds at greater heights. In fact above 20,000 feet the two streams had practically the same temperature and could be regarded as merged into one great west to east current.

In the lower layers, however, the streams were separated by a transition zone or frontal surface sloping upwards from south to north with a gradient of about 1 in 50. Such a zone or front is a region where bad weather with extensive masses of cloud of cumulo-nimbus type is frequently, though not invariably, found. In such clouds dangerous icing is a recognised hazard and in winter it may occur at comparatively low altitudes. The position of this zone in relation to the "Saint Kevin's" route is therefore of prime importance. In the early morning of January 10th the front, at sea-level, ran westwards from the North of Ireland and during the forenoon it moved rather slowly northward and extended eastward. In the afternoon it began to move south and by 1800 hours had regained its early morning position in N.W. Ireland and ran from there just north of the Isle of Man and thence to the Humber. Subsequently it moved more rapidly southwards and reached Dublin at about 2100 hours and North Wales about an hour later or 3 hours after the time of the accident.

The bad weather associated with such a front is usually limited to a narrow band a few miles wide at the front itself and in advance of it though in some cases the bad weather extends a substantial distance in advance of the front. A careful examination of the recorded observations of cloud and weather in advance of this front, as it moved south across the country, shows that it did not come into the latter category. The hail and snow reported by witnesses as occurring in the Welsh mountains after the accident but before the passage of the front cannot therefore be explained as due to an over-running of cold air from the north in advance of the front. The explanation must be sought in another direction and this will be indicated in the immediately following paragraphs.

23. Where the air-stream turned eastwards, between 300 and 600 miles south of Greenland, the freezing level on the afternoon of 9th January was at a height of 10,000 feet. It had fallen about 2,000 feet in the preceding 24 hours, through cooling by radiation as the air moved northwards. It was this section of the airstream which reached England in the afternoon and evening of 10th January after travelling another 1,500 miles across the Atlantic Ocean and Ireland. Its temperature, at heights above 1,000 feet, was still so high that the cooling of the upper layers through radiation continued though more slowly. Thus when 12 hours later, at 0300 hours on 10th January, this section of the airstream reached a British Weather Ship ("Weather Watcher") in lat. 53° N., long. 18½° W., the freezing level was still above 9,500 feet.

Gradually this air, originating from the eastern side of the original northward moving airstream, was being followed in its track towards England by air, still from the same general stream, coming from further west. This latter air had followed a longer track over the ocean. It had also come over an area of the ocean of much lower temperature. Consequently it had cooled appreciably more in the layers between 3,000 and 8,000 feet. It arrived earlier in the upper layers above 3,000 feet owing to the greater speed of the wind in these layers with the result that the freezing level at "Weather Watcher" fell after 0300 hours on 10th January at the rate of about 1,000 feet in 6 hours, although the temperature near sea-level showed no change.

For a similar reason, the freezing level was lower in the stream 150 miles north of "Weather Watcher" than at "Weather Watcher" though this was still the warm airstream and distinct from the cold stream mentioned in paragraph 22. It was this section of the warm airstream which reached North Wales.

While the temperature of the upper layers fell, the temperature of the lowest strata of the airstream increased as the air moved eastwards from south of Greenland to Ireland. It rose from 45° F. to over 50° F. owing to the increase in the temperature of the ocean from west to east in the track of the airstream. In labile air this increase of temperature would have lifted the freezing level about 1,000 feet. In fact it had no direct convective influence on the freezing level in this stable air, with its high freezing level, and the effect of the increase in radiation was insignificant.

The result of these different causes affecting the height of the freezing level was a reduction from the 9,500 feet recorded at "Weather Watcher" to 7,500 feet in the section of the airstream reaching N.W. Ireland near 1500 hours on 10th January. This was the section of the stream which reached the Daventry-Nevin section of the route of the flight about 4 hours later when the "Saint Kevin" was in it.

24. When the air in this rapid stream reached Ireland a new factor of change began to operate on it, viz., large scale turbulence. Over the ocean the turbulence arising from the contact of air and water acts very slowly in changing the lapse-rate of a stable airstream towards the labile rate.

It takes many days for the effect of such turbulence to spread upwards 6,000 feet. This is the approximate height at which freezing level would be reached in the airstream of 10th January if the stream were transformed by mechanical turbulence from a stable to a fully labile state up to that height. Over level or undulating country the process is still relatively slow and the time for the transformation would still be more than a day. But the large scale turbulence in a 60 knot stream crossing coastal cliffs and mountainous country extends the change of the lapse rate much more rapidly upwards and the process was assisted on the afternoon of 10th January by the reduction of temperature already mentioned in the layers between 3,000 and 8,000 feet.

When the air reached the Irish Sea it had already lost some of the stability it had possessed over the Atlantic. It underwent a further change when it was over the Welsh mountains. There, as it was lifted, it cooled at the full labile rate. This affected both the freezing level and the weather.

The temperature of the air at 4,500 feet, approaching the mountains from the Irish Sea, deduced from the considerations outlined and the radio-sonde observations, was 38° F, and the freezing level between 6,500 and 7,000 feet. Making the reasonable assumption that the air at 4,500 feet was lifted 1,500 feet, about half the height of the Snowdon range, its temperature on reaching the 6,000 feet level, as it crossed the range, would have fallen to freezing point, thus lowering the freezing level by more than 500 feet.

As the airstream rose over the mountain range, a high percentage of the moisture in it was condensed and in the violent local upcurrents, to be expected when the 60 knot airstream met the steep western face of the range, snow would be formed above the freezing level and possibly small hail, though not the usual hail of thunderstorms. The snow, as it fell through the cloud below freezing level, picked up water and melted, producing, as it must by established theory, the rain which fell in the mountains, in contradistinction to the drizzle which characterised the weather of the nearby sea-level meteorological station at the Royal Air Force Station, Valley, in Anglesey.

The rain so formed would be carried rapidly away from its source, but the possibility of its subsequently meeting another ascending current and being carried up again above the freezing level cannot be wholly excluded in the turbulent conditions prevailing over the extensive area of the Welsh mountains on the evening of the 10th January. The ascending current would need to be stronger than 1,000 feet per minute. If the raindrops were carried up, they would become super-cooled and would produce clear ice on an aircraft meeting them. But the cloud of such drops above the freezing level would necessarily be of small horizontal extent in the direction of the airstream and an aircraft would be quickly through it—probably in less than a minute.

The violent local upcurrents mentioned would have their counterpart in intense local downcurrents on the lee side of the mountain range, and these downcurrents would not be confined to levels below the top of the mountain range. Observations, notably over the Rock of Gibraltar as well as in many other mountains, show that such currents may be found at heights at least double those of mountains of heights comparable with those of North Wales : and that the downward speeds may reach values of 1,000-2,000 feet per minute in winds half the strength of those on 10th January.

Part IV

THE FLIGHT PLAN AND BRIEFING

25. It is the practice of Aer Lingus to leave the choice of route as between the three available routes between Northolt and Dublin to the Captain. On the occasion under investigation Captain [redacted] after consulting the Duty Forecaster of the Air Ministry Meteorological Office at Northolt about the weather, selected the Daventry-Nevin route and the flight plan was drawn up by the Operator's Station Officer accordingly. The two alternative routes are (i) following Airway Amber One and Airway Green Two. This route passes over Wallasey and is commonly referred to as " the Wallasey route " ; (ii) by way of Airway Green One to Filton and Strumble Beacon and thence to Dublin. This route is known as " the Bristol route ".

It was the consensus of opinion of all the experienced Aer Lingus Pilots who gave evidence that this choice was justified by the information available to Captain [redacted] each witness saying that he would have made the same election.

26. It is necessary at this point to consider the state of Captain [redacted] own knowledge of the weather conditions prevailing along his chosen route over which he had in fact flown that afternoon from Dublin to Northolt arriving at Northolt a little over an hour before taking off on the fatal flight.

While it is impossible to say that a period of some three hours may not show dramatic changes in stormy winter conditions it is at least possible to draw some useful conclusions from recent experience in the same airstream.

Captain [redacted] quite certainly knew that that there were strong winds of about 60 knots from a north westerly direction because his east-bound flight had occupied only 1 hour 25 minutes which is a fast time for this route. He had apparently also experienced some icing when at 7,500 feet over the Welsh mountains for there is in existence a record of an aircraft-to-aircraft conversation between him and a westbound pilot at 1548 hours (when he was nearing Daventry) in which in reply to a question " what is it like over the hills now ? " he said " it is not too bad, quite a bit of icing, we had to go up to seven five due to other traffic at five five, the lower the better I'd say ".

It is, however, noteworthy that there is good evidence that neither Captain [redacted] nor First Officer [redacted] said anything after their arrival at Northolt to either of the responsible officers with whom they spoke there about having experienced icing ; nor did they report that any anti-icing fluid had been used. This circumstance coupled with the experiences on this day of certain other pilots has led the Court to conclude that the icing spoken of in the quoted message cannot have been serious or of a dangerous character.

27. On arrival at Northolt at 1620 hours on the 10th January Captain [redacted] was not prepared to tell the Station Officer then and there by which route he wished to return to Dublin. He insisted on going first to the Meteorological Officer for briefing on the weather situation and was accompanied by First Officer [redacted] The main concern of the two pilots in their conversation with the Duty Forecaster appeared to her to be the conditions at Dublin. They said nothing to her about icing notwithstanding that, as they must have known, it is part of the duties of her post to accept the " debriefing " reports of newly arrived pilots.

The salient features of the Flight and Terminal Forecast issued to Captain [redacted] which was on the conventional Air Ministry Meteorological Office Form 2408 were these :—

(i) for the southern section of the route

Wind at 2,000 ft. 290° 45 kts. Temp. +06°C
" " 5,000 " 300° 60 " " +05°C
" " 10,000 " 300° 75 " " −02°C

(ii) in the northern section of the route

Wind at 2,000 ft. 270° 30 knots
" " 5,000 " 290° 48/52 knots
" " 10,000 " 290° 60/62 knots

the temperatures being the same in both sections.

The type of weather was described as : " cloudy —occasional drizzle with outbreaks of rain occasionally moderate in Midlands and NW."

The height of the cloud base above MSL was forecast at 700-900 feet with patches down to 400 feet over England and Wales rising to 1,800-2,200 feet over the Irish Sea.

The freezing level was given as 8,000 feet (with a tolerance, indicated by a footnote printed on the form, of plus or minus 30 per cent) over England and Wales and 8,000-9,000 feet (no tolerance allowed) over the Irish Sea.

The type of Ice Formation to be expected was given as " Slight-moderate rime ".

The Court takes this early opportunity of putting it on record that upon the material available to her which (save as to the subject matter of the recommendation contained in paragraph 74 below) was all that was reasonably necessary for her purpose, the Duty Forecaster's conclusions were as nearly accurate as could reasonably be expected of anyone.

28. It is of great interest in this connection to observe that on the 10th January a special research flight was undertaken from Northolt over the Midlands with the special object of looking for icing conditions. The pilot of the aircraft so engaged was briefed by the Meteorological Office at Northolt with the intention of sending him where icing was most likely to be found. In fact he found only a very slight rime deposit on the wings when still close to London on the return leg of his tour at about 1400 hours. This flight was carried out wholly in the cold air in advance of a warm front which crossed England between dawn and dusk on the 10th January and so was more likely to encounter icing than would have been an aircraft flying at the time and on the route of the " Saint Kevin's " flight save only that the latter's course lay over mountains. It was upon the " debriefing " from this research flight that the Duty Forecaster added " slight " before the already-written-in words " moderate rime " in her forecast for the " Saint Kevin's " flight.

29. On the forecast thus obtained and with whatever impressions his own experience on his outward flight from Dublin may have made upon his mind, Captain [redacted] elected to fly the Daventry/Nevin route and the Operator's Station

Officer prepared the " flight plan " accordingly. This " flight plan " shows no peculiarities or mistakes and it can be assumed that if it was used for the purpose for which a " flight plan " is intended, i.e., to give the pilot such navigational help as can be given from the ground and not relied upon as dispensing the Pilot from the obligation of ascertaining his position from time to time by the proper use of navigational devices while in flight it should not have led the aircraft into trouble.

30. It is to be remembered that both Captain [redacted] and First Officer [redacted] were thoroughly familiar with the route they were flying and the navigational aids available upon that route.

These aids may be classified under four heads :

(*a*) transmitting stations on which the radio compass can be tuned ; these were :—

Dunsfold Radio Range
Daventry Radio Beacon
Droitwich (B.B.C.)
Filton Radio Range
Burtonwood Radio Range
Nevin Radio Beacon
Strumble Radio Beacon
Dublin Radio Beacon.

(*b*) VHF bearings ; obtainable by radio telephony upon request from :

Liverpool (Speke)
Ronaldsway I.O.M.
Dublin
Manchester (Ringway).

(*c*) Gee : available over the whole route.

(*d*) SBA landing aid at Shawbury R.A.F. Station.

Part V

THE FLIGHT

31. The " Saint Kevin " took off from Northolt at 1725 hours on the 10th January, 1952. According to the " flight plan " Daventry should have been reached at 1759 but the aircraft reported to Uxbridge (London Airways) at 1756 hours by R/T with the words " checked Daventry ".

At Daventry up to which point the average ground speed was 97 nautical miles per hour (hereinafter referred to as " knots ") the aircraft had to turn on to a course which brought the wind about dead ahead with a consequent reduction of about 8 knots in the ground speed. At 1800 hours the " Saint Kevin " reported to Uxbridge (South Eastern Flight Information Region) giving the time of passing Daventry as 1756 hours as in the previous message and estimating the time of passing over the point at which the course line cuts the 3rd meridian west of Greenwich (hereinafter called " 3° W.") as 1841 hours implying an estimated ground speed of 96 knots.

At 1836 hours the aircraft reported to Uxbridge (SEFIR) with the words " Check three degrees west ", and because on passing that point it entered the Northern Flight Information Region, at 1838 hours reported to Preston (NFIR) " . . . . check three west now estimate Nevin one zero (i.e. 1910 hours) and Dublin one nine five one (i.e. 1951 hours) ".

Assuming that 1838 hours, when the words " check three west now " were used, was the time at which Captain [redacted] believed that he was at 3° W. he could then have seen that his ground speed from Daventry to that point must have been 103 knots or 7 knots more than his estimate at Daventry and 18 knots more than indicated in the flight plan. This value is much too high in view of the undisputed values of air speed and wind speed.

In view of the foregoing it is impossible for anyone to say where the " Saint Kevin " actually was at 1838 hours or at what time 3° W. actually was reached.

The anticipated ground speeds implied by the 1838 hours report to Preston were 101 knots between 3° W. and Nevin and 106 knots between Nevin and Dublin, respectively 6 knots and 11 knots higher than the speeds in the flight plan.

32. About sixteen minutes before the estimated time of reaching Nevin, i.e. at about 1854 hours, the " Saint Kevin " asked Preston for permission to ascend to 6,500 feet. Permission was given almost immediately and not later than 1855½ hours the aircraft reported " leaving four five now " and at an unascertained moment between 1858 hours and 1902 hours reported " Check six five ". According to the estimate made at the time when the Captain thought he was at 3° W. he would at 1858 hours have been in a position about 8 nautical miles from the coast at Harlech, or about 16 nautical miles almost due south of the place of the crash. The next signal received from the " Saint Kevin " was " check Nevin " : this was received by Preston before 1912 hours and was followed by an instruction from Preston

to the aircraft to change frequency to Dublin. Before leaving the Preston frequency however, and still before 1912 hours, the " Saint Kevin " asked Preston " Have you any news of any outbound aircraft from Dublin on the London Route " and was told " Affirmative Easy Charlie Item departed Dublin at one eight four eight estimating Nevin at one two minutes past the hour (i.e. at 1912 hours) ". A second message from Preston at or immediately before 1912 hours added the information that Charlie Item was at 5,500 feet and immediately afterwards the " Saint Kevin " called up Charlie Item and said (as already set out in paragraph 5) " You'll find it pretty rough over the hills tonight we were at four five went up to six five it seems to be right through ".

Shortly after 1912 hours and before 1915 hours the " Saint Kevin " having changed to the Dublin frequency reported " We checked over Nevin a minute ago flying six five IFR. We just passed Charlie Item. Request descent clearance please ". This signal was acknowledged by Dublin and the desired clearance given. It is not known whether Dublin's signal was ever received by the " Saint Kevin " from which nothing further was heard by any receiving station.

It should be noted here that according to the flight plan Nevin should have been reached at 1924 hours while the " Saint Kevin's " own ETA at Nevin given in the last signal which contained any such estimate (i.e. the 1838 hours message to Preston) was 1910 hours, a difference of 14 minutes. For the aircraft to have been where it was reported to be when the signal " check three degrees west " was sent it would have had to have gained 12 minutes on the flight plan estimate. The Court being satisfied that the wind speed was not less than 55 knots was forced to the conclusion that after leaving Daventry, which was probably reached at the time reported, the " Saint Kevin " was always well behind the points which the pilots believed they had reached.

33. The only evidence about the last moments of the flight comes from the recollection of witnesses on the ground. None of these had any duty to remember or record anything about the auditory sensations from which alone they could derive any impression of the behaviour of the aircraft. The Court is unwilling to base any finding upon the obviously honest but equally obviously inconclusive evidence of such witnesses. This caution is the more compelling upon the Court when it is remembered that it was a wild night of high and gusty winds which no doubt created much noise themselves and would have distorted other noises.

Part VI

THE WRECKAGE

34. Everything possible was done by the staff of the Accidents Investigation Branch of the Ministry of Civil Aviation to locate, collect and examine the debris resulting from the crash. Little of value however can be derived from a study of the material so obtained.

35. The aircraft struck the ground in a soft peat bog about 1½ miles east of Lake Gwynant in Caernarvonshire at a height of about 1,200 feet above mean sea level. Most of the wreckage was swallowed up by the bog in which the engines completely disappeared. The main part of the wreckage was at the most westerly point at which any part of the debris was found, small fragments mainly of wing skin being found up to 1¼ miles to the eastward. The only detail of importance in this trail was the outer portion of the starboard wing which broke off about 26 feet from the wing tip and was found about 266 yards from the main wreckage.

The posture of what was left of the port wing and fuselage suggested that the aircraft struck the ground at a steep diving angle of 80° heading about north.

There was evidence of extensive disintegration upon impact and a fire had occurred in or about the main crater. The fragments lying to the eastward of the main crater showed no signs of burning.

The condition and location of the propeller blade fragments were consistent with the engines being under considerable power at the moment of impact.

36. The location of the largest detached fragment of the starboard wing together with a study of the fractures of the spars indicated that the wing had broken shortly before the aircraft struck the ground and suggested that the breaking had been caused by over-stressing beyond the designed limits for up-load in an upward and backward direction.

37. The control valve of the de-icing equipment was recovered broken away from the bulkhead to which it was attached and was found to be jammed in the " on " position.

38. There can be no doubt but that all the occupants of the " Saint Kevin " were killed instantaneously upon impact with the ground.

PART VII

THE WEATHER

39. The sun had set at 1611 hours and civil twilight ended at about 1700 hours, well before the "Saint Kevin" took off from Northolt. There was, however, a nearly full moon which had risen just before 1400 hours. During the flight the moon was well up in the sky and at the time of the accident its altitude was about the same as the sun's mid-day altitude at the beginning of April. There would, therefore, not be complete darkness above the clouds or in the breaks between them. In fact the Captain of another aircraft flying along the route at 6,500 feet about 50 miles behind the "Saint Kevin" described the flight along the airways, prior to reaching the Welsh mountains, as "quite a pleasant trip": and a resident of Beddgelert who was asked immediately after the accident to look out for any fire which might help to locate the aircraft saw a reflection in the sky which he thought, correctly, might be the moonlight piercing the cloud.

40. The only direct evidence from the "Saint Kevin" itself of the weather actually experienced in the flight is the message to another aircraft at 1912 hours that it was rough over the hills both at 4,500 and at 6,500 feet. The "Saint Kevin" was in communication from time to time with the control stations at London and Preston and at no time made mention of the weather or of any difficulty arising from it. The evidence of the weather met by the "Saint Kevin" is therefore mainly indirect. It can, however, be stated with certainty that the wind was about 60 knots and for most of the flight was nearly a direct head wing and that there was neither much turbulence nor bad cloud conditions along the route from Northolt to Wales. Only over the Welsh mountains did the aircraft meet the substantial turbulence implied in the message mentioned.

41. The value of 60 knots for the wind, derived from the meteorological observations and computations is confirmed by the value calculated from the times taken on six other flights along the Daventry-Nevin section of the route. The average value obtained from the records of these six flights at levels of 4,500, 5,500 and 6,500 feet between 1500 hours and 2200 hours on 10th January is 60 $\pm$6 knots.

42. Evidence was given by the pilots of four other Aer Lingus DC-3 aircraft which flew along the same route as the "Saint Kevin" in the afternoon and evening of the 10th January. The first of these aircraft, EI-ACI, flying from Dublin to Northolt, at 5,500 feet, passed the Nevin Beacon at the same time (i.e. 1912 hours) as the pilots of the "Saint Kevin" flying at 6,500 feet reported that they were passing it. This aircraft, EI-ACI, left Dublin at 1848 hours and had very smooth conditions over the Irish Sea. It received from the "Saint Kevin" the warning about rough conditions and shortly afterwards ran into quite rough turbulence near Barmouth but "not a bit different" from what the Captain had been led to expect from his briefing at Dublin. The aircraft also passed through fairly heavy rain at times and had occasionally a "very, very small amount of very wet ice on the wind screen but none at all sticking to the aircraft". The temperature reading was +2° C. except in cloud where it fell to −1° C. After a period estimated at 10 to 12 minutes (clearly over-estimated, as will appear) the turbulence ceased, the cloud at and below 5,500 feet broke and the 1st Officer saw Welshpool as the aircraft passed near it.

43. The second aircraft, EI-ACT, was flying from Paris to Dublin at 6,500 feet. This was the aircraft which had had "quite a pleasant trip along the airways". It passed above the aircraft EI-ACI at 1922 hours and about 10 minutes later met turbulence which gradually increased in severity and was accompanied by icing, sufficient in quantity to cause eventually a substantial decrease of air-speed. One of the pilots said he saw hail but the other pilot saw no hail and was certain that if there had been hail he would have seen it. The turbulence and bad weather experienced by this aircraft appears certainly to have been the same as that through which the aircraft EI-ACI had flown just before in the opposite direction and at a level 1,000 feet lower. This bad weather was either a patch travelling within the 60 knot airstream or it was a purely local effect produced in the airstream by the mountains and restricted to the mountain region. An examination of the times, taken in conjunction with the known speed of the aircraft, shows that if the bad weather had been a travelling patch, the aircraft EI-ACI must have cleared it at about 1916 hours or 4 minutes after leaving Nevin. This was certainly not the case. The conclusion is that the bad weather was, in fact, a local effect and was left behind by EI-ACI between 1919 and 1920 hours. It extended inland only about 15 miles from the Welsh coast near Harlech. The aircraft EI-ACI was in it for about 4 minutes and the aircraft EI-ACT for about 10 minutes.

44. The aircraft EI-ACT, after reaching the Welsh coast at a point on its planned route about 10 miles from the Nevin Beacon descended, by permission from Preston, to 4,500 feet to escape

the icing and then, owing to shortage of fuel (a circumstance which had been pre-occupying the pilots), diverted to Liverpool, flying at 5,000 feet along a route which took it within about 5 miles of the wrecked "Saint Kevin" 40 minutes after the accident. On this part of its flight, EI-ACT experienced no icing and less turbulence, so much less in fact that the Captain and the 1st Officer could, and did, interchange seats.

The aircraft EI-ACT had picked up some rime as it climbed to its flying level of 6,500 feet in France. This rime did not clear from the aircraft in the warmer air over England, for a reason which will appear in paragraph 61. The rime was believed to be a contributory cause of a reduction in the aircraft's air-speed from the 148 knots of the flight plan to 130 knots. But it seems clear from the times of the flight on the English section of the route that the true air-speed there was substantially in excess of 130 knots. The aircraft flew the 116 miles from Daventry to the point of diversion near Harlech in 84 minutes against a 60 knot head wind which implies an average air-speed of 143 knots.

45. A third aircraft EI-ACD flew from Northolt to Dublin earlier in the afternoon. It left Northolt at 1515 hours and flew at 4,500 feet all the way, passing Daventry at 1551 hours and the Nevin Beacon at 1706 hours. The weather experienced was "reasonable" until about 30 miles from Nevin when some cumulus cloud, heavy rain and moderate turbulence was met over the mountains.

46. A fourth aircraft EI-ACL left Dublin at 1745 hours and reached Northolt at 1905 hours. It returned to Dublin, leaving Northolt at 2017 hours and arriving at Dublin at 2255 hours. On the first flight at 5,500 feet it was smooth over the Irish Sea. There was short and sharp turbulence around Barmouth and afterwards "nothing much." There was no icing and no precipitation. Temperature was +2° C. On the return flight at 4,500 feet there was no icing and no precipitation but it was fairly turbulent, "no worse however over the mountains than it had been over England." The turbulence, though definite, was not sufficient to lift the Captain off his feet as he went to the passenger compartment to satisfy himself that all was well there. The temperature was +4° C.

47. This evidence of the weather conditions at the levels of flight, based in the main on the recollections of pilots and not on records made at the time, is substantially in accord with the deductions of the meteorological experts from their charts of observations and records of upper air conditions obtained from radio-sondes. It may be supplemented with advantage by the observations recorded at the time at official meteorological stations near the route. At the Royal Air Force Aerodrome, Valley, in Anglesey, about 20 miles directly to windward of Snowdon there was slight drizzle, slight rain and slight mist in the period from 1500 hours to 2100 hours with a cloud base 1,700 feet at 1800 hours. At the Royal Air Force Aerodrome at Shawbury about 60 miles directly to leeward of Snowdon and about 15 miles north of the route there was slight rain followed by intermittent moderate rain in the same period with a cloud base at 2,600 feet at 1800 hours. At Elmdon near Birmingham there was intermittent moderate rain, in the same period, with a cloud base at 3,100 feet at 1800 hours. At Cranfield, between Elmdon and London, there was no rain in the period and the cloud base was at 2,200 feet at 1800 hours, while at London there was slight intermittent drizzle and slight mist in the period with a cloud base at 2,000 feet at 1800 hours. At Collinstown near Dublin there was a slight drizzle with a cloud base at 1,500 feet at 1800 hours and there had been some rain during the day. At all these places the amount of rain was small. In the 12 hours from 0900 to 2100 it was 1/5th inch at Valley and Shawbury, 1/6th inch at Collinstown, 1/12th inch at Elmdon and 1/25th inch at Cranfield and London.

Witnesses from the neighbourhood of the accident gave evidence of the severity of the gale and the variability of the weather in the mountains. According to their evidence it had been a showery day. At the time the aircraft was heard just prior to the crash in Cwm Edno it was not raining at a farm a mile to the west but it was raining heavily at a place 3 miles to the west. Shortly after the accident it came on to rain as the farmer was going up to Cwm Edno. About half an hour later there was rain and sleet interspersed with hail 1½ miles to the east and between 1½ and 2 hours after the accident a search party experienced hail and snow on the mountain about 3 miles to the north-east of Cwm Edno. There was no evidence of snow, sleet or hail prior to the accident.

The evidence of the radio-sonde ascents indicates that at 4,000 to 6,000 feet the wind was from the direction 290° to 295° and its speed 55 to 60 knots and that the freezing level on the route was 7,000 feet falling after Daventry to 6,500 feet and over the mountains to 6,000 feet.

48. As mentioned in Paragraph 22 the cold front reached North Wales at about 2200 hours and an aircraft carrying officials of Aer Lingus from Dublin flew thence to Valley in comparatively clear weather and full moonlight behind the front, landing at Valley at 2345 hours.

PART VIII

POSSIBLE CAUSES OF THE ACCIDENT

49. *A reconstruction of the flight after Daventry*

It is necessary first to state the few facts which are known.

The "Saint Kevin" struck the ground not later than 1915 hours in a position about 18 nautical miles distant and bearing about 60° from Nevin Beacon. This position is about 14 nautical miles from the nearest point on the direct course from Daventry to Nevin.

It must be stated at once that except on an "airway" there is nothing inherently wrong about being knowingly a few miles one side or the other of a planned course without reporting the fact. The significance of these known facts however lies in the circumstance that the deviation of the "Saint Kevin" so far to the northward of the planned course brought the aircraft into the lee of Snowdon at a time when according to his signals the Pilot must have thought he was clearing the last of the Welsh land and reaching the Irish Sea.

50. It seems likely that the beginning of the error which led the Pilot to believe that he was at Nevin at a time when the distances recorded in the immediately preceding paragraph show conclusively that he could not have been there must be looked for in the stage of the flight between Daventry and 3° W. The ground speed assumed by the Pilot for this leg as indicated by his signal to Uxbridge (SEFIR) timed 1800 hours was 96 knots whereas the flight plan estimated a ground speed of 85 knots.

It must be a matter of speculation but it may be that the Pilot was led to overestimate his ground speed for the leg Daventry-3° W. because his experience on the leg Beacon Hill-Daventry had shown him a ground speed of 98 knots against a flight plan estimate of 93 knots.

There is no means of telling where the "Saint Kevin" was when the report "check three west now" was made at 1838 hours but the aircraft could not in fact have been at 3° W. without having made good a ground speed of 103 knots from Daventry or 18 knots better than the ground speed estimated in the flight plan.

51. There is no evidence from which the Court can say whether the Pilots used any or if any what navigational aids on that night. All that can be said is that no signal from the "Saint Kevin" gave any hint or suggestion of anxiety, difficulty or confusion in the minds of those flying the aircraft. Their messages to Preston and Dublin announcing their position with reference to Nevin were clear and unequivocal. The request for permission to ascend to 6,500 feet was not explained, though inferentially it can be said to have been due to turbulence or anticipated turbulence: it was probably made at about the time the aircraft was approaching the lee side of the Berwyn Range. What may seem hard to understand is why, at a time when the "Saint Kevin" must in fact have been getting near the lee side of Snowdon, the Pilots requested permission to descend. The probable explanation is that the Captain, believing in his own erroneously-arrived-at estimated time of arrival at Nevin and perhaps having experienced sufficient icing to lead him to switch on his de-icing boots, desired to come down to the first permitted quadrantal height (4,500 feet) above the safety height (3,000 feet) for the leg Nevin-Dublin as a first step in his run in to Dublin.

52. It is less easy to see what led to the deviation to the northward of the track than to see what led to the Captain believing that he was further ahead than he was. In the absence of any fix after Daventry no-one can say what compass course was being steered or what allowance was being made for lateral drift. It is possible that some mistake was made but there is no evidence of it. The most likely explanation is that the wind was not as far round to the northward as forecast and allowed for in the flight plan. The wind indicated in the flight plan was blowing from 300° at 60 knots whereas the actual wind was 290°/295° at 55/60 knots. Unless the Pilots obtained at least one fix or correctly identified some ground lights after turning into the wind at Daventry they would have had no means of correcting by experience the wind estimated for them in the flight plan. It is also possible that Captain [redacted] may have glimpsed lights on the ground and although a very experienced Pilot on this route misinterpreted them.

53. The Court is inclined to the view that the explanation of the fatality may be found under one or more of the following three heads:—

(*a*) The Pilot, being in error as to his true position began his descent from 6,500 feet to 4,500 feet and before he realised it ran into an unusually strong downward current in the lee of Snowdon. This downward current took him below the level of the crests of the mountains. In such a current an aircraft could lose 2,000 feet of height before any action for recovery

of height could be effective. Once the aircraft reached a level below the crests of the mountains, it would, in the conditions prevailing there at that time, be in a region of most chaotic turbulence from which in the darkness there would be the greatest difficulty in regaining control and recovering height. While the Pilot was making an effort to do this, the aircraft encountered an unusually violent local gust which put the aircraft completely out of control and produced the stresses which broke off the starboard wing and plunged the aircraft into the bog.

(*b*) The aircraft ran into a region of unusual violent turbulence which dislodged the Pilot from the controls. Before he could recover control of the aircraft, it had got into an attitude from which control could not be regained before the aircraft hit the ground after losing a wing owing to the stresses set up.

(*c*) The aircraft ran into a region of violent turbulence which dislodged moveable equipment in the cockpit, which in its turn jammed the controls or injured the Pilot and produced the same result as in (*b*).

54. The Court has considered the possibility of the accident being caused by icing on the aircraft and has rejected it on the following grounds:—

(*a*) Icing takes time to build up. It could not have been deposited in sufficient amount to stall the aircraft in the interval between the warning of rough conditions to the aircraft EI-ACI and the accident.

(*b*) If the icing had been appreciable before the warning mention of it would almost certainly have been included in the warning.

(*c*) If the icing had been appreciable the Pilot would not have waited until he was past Nevin (as he thought) before asking for permission to descend below the freezing level.

At the same time the possibility that icing was contributory to the difficulty of control in the conditions mentioned in Paragraph 53 (*a*) cannot be excluded.

Part IX

COMMENT AND DISCUSSION

55. *Frequency of High Winds*

Winds at a height at 5,000-6,000 feet on any of the three routes between London and Dublin may exceed 50 knots in any month of the year. Winds of this speed blow mainly from a west or northwest direction. On the average in the winter months one day in four has such winds but in summer they do not occur more than once a month. Winds exceeding 60 knots occur about once in 20 days in winter and twice a year winds exceed 70 knots. The highest value measured at Liverpool at this height in the three years 1948-1950 was 84 knots from a direction 290°. It is clear therefore that gales from between west and northwest, as bad or worse than that of 10th January, 1952, may be expected in the future.

56. *Turbulence in High Winds over Mountains*

It is clear from observations in manned balloons, in gliders and by pilots of aircraft that substantial vertical currents are produced even when an airstream of moderate speed crosses a mountain range. Vertical currents of 800 feet per minute have been experienced on the lee-side of mountains 1,500 feet high, in a transverse wind of only 20 knots. As already mentioned the investigation of vertical currents caused by the Rock of Gibraltar showed that the turbulence extended upwards to a height of more than 5,000 feet. Over a mountain range much higher than the Rock strong vertical currents may be expected up to heights at least 3,000 or 4,000 feet above the crest of the range, especially in transverse airstreams of low stability. In such conditions the normal clearance of 1,000 feet does not give adequate protection against the hazards of turbulence. For air routes over mountainous regions, where an alternative route is not available or is excluded by other weather hazards, the specified safety level should be related to the meteorological conditions.

57. *Height of Freezing Level*

In regions covered by a satisfactory network of radio-sonde observations, the height of the freezing level can usually be specified with a higher degree of accuracy than ±1,000 feet. The height can also be forecast with the same degree of accuracy for flights over the region, other than at times when changing conditions are being rapidly imported from regions where there is no satisfactory network. The degree of accuracy is not proportional to the height; it is, in such a region, substantially independent of the height. Consequently a percentage tolerance is not appropriate for specifying the degree of accuracy of the height of the freezing level.

58. *Effect of Mountain Range on Height of Freezing Level*

When a thermally stable airstream crosses a mountain range transversely, the freezing level

will be lowered owing to the lifting of the air and its consequent expansion and cooling. For example if the air over Larkhill at 1500 hours on 10th January had been lifted just over 300 feet, the freezing level would have fallen from 7,500 feet to just over 6,000 feet. The change in the height of the freezing level due to this cause disappears when the airstream again reaches lower ground unless the lifting has produced rain over the mountains in which case the freezing level may be at a greater height after the airstream has crossed the mountains than it was before. Although approximate estimates of the magnitude of the effect can be based on theoretical considerations, direct observations at different levels along stable airstreams crossing the mountains appear necessary to provide the data for the formulation of rules for the guidance of meteorological briefing officers.

59. *Effect of Mechanical Turbulence on Height of Freezing Level*

When an airstream, thermally stable over the ocean, crosses land irregular enough in height to cause excessive turbulence the height of the freezing level may be reduced. This effect, unlike that due to lifting over a mountain range persists even when the airstream reaches level or nearly level ground whose average level is not lower than that of the irregular land. The magnitude of the effect on lapse-rate which can be caused by mechanical turbulence arising in this way and the height to which it can appreciably extend can be obtained by direct observation at different levels along airstreams initially stable.

60. *Temperature of the Air*

A thermometer on an aeroplane is subject to heating owing to its speed through the air, and the temperature recorded is usually too high. For a thermometer under the wing or nose of an aircraft, properly shielded from radiation, the correction necessary to allow for this effect is approximately 2° C. for an air-speed of 140 knots and 4° C. for an air-speed of 200 knots. At the freezing level the recorded temperature would be +2° C. or +4° C. at these two speeds. The result might well be to give a pilot an unjustified sense of security against icing, if, as appeared from the evidence in this case, no provision was made for ensuring that pilots knew the correction required to the actual readings to give the true temperature of the air. In view of the importance of icing as regards both performance and safety it seems essential that pilots should know the correct temperature of the air through which they are flying especially when this is in the neighbourhood of the freezing point.

61. *Melting of Rime or Ice on an Aircraft*

The melting of rime or ice on an aircraft in flight depends upon the " wet-bulb " temperature. In dry air the " wet-bulb " temperature may be several degrees lower than the air temperature and if it is below freezing point rime or ice will not melt, even if the air temperature is well above freezing point. In such a case the rime or ice would evaporate but this is a slow process. The non-clearance of the rime, collected over France by the aircraft EI-ACT, during the time the aircraft was flying over England in air at a temperature above freezing point appears to have been due to the fact that the " wet-bulb " temperature was below freezing point.

The effective " wet-bulb " temperature is that which would be recorded by a " wet-bulb " thermometer without correction for the speed of the aircraft and situated in the position where the rime exists.

It is pertinent to add that snow or hail falling through air at a temperature above freezing point would not begin to melt unless the corrected " wet-bulb " temperature was also above freezing point.

62. *Radio-Sonde Observations*

The network of radio-sonde stations in the British Isles appears to be adequate to enable the meteorological briefing officers to meet the requirements in this respect of civil aviation except on those occasions when changes are occurring with unusual rapidity. On such occasions it is for consideration whether intermediate observations could be made at key stations selected according to the actual meteorological situation and, in particular, an observation on such an occasion at 0900 hours or 2100 hours at Valentia when the meteorological situation indicated Valentia to be a key station.

63. *Consultation with Meteorological Briefing Officer*

It emerged in the course of the Inquiry that there was on occasions insufficient time between the arrival at and departure from an airport for pilots to visit the meteorological officer and receive personal briefing on the meteorological situation. It appears desirable to make such amendment of schedules or instructions as may be necessary to avoid the recurrence of such occasions.

64. *Notification of Meteorological Changes*

It emerged in the Inquiry that a change in the meteorological conditions affecting an air route might arise which (*a*) was not within the knowledge of, or foreseeable by, the meteorological

briefing officer before the departure of an aircraft flying along the route; (*b*) did not constitute a recognised hazard but might nevertheless lead the pilot unwittingly into a situation of difficulty or into a region where a recognised hazard existed or was developing. Such a change would not, under existing arrangements, be communicated to the aircraft. It appears desirable to ensure that an actual or imminent change on any section of a route which the appropriate meteorological officer recognises as an appreciable change in the conditions affecting the safety of aircraft should be notified on his authority to the aircraft, unless he is aware that the change has been specified in the forecast provided for the pilot before departure. This last proviso applies only when the appropriate meteorological officer is at a station other than the departure airport. A meteorological officer at the airport would be aware of the forecast provided.

It is no part of the duty of this Court to make specific recommendations as to the administrative measures (involving both the Air Ministry and the Ministry of Civil Aviation) necessary to be taken to give effect to what is here suggested.

65. *Sufficiency of the Crew*

It has already been made clear that no-one will ever know what, if any, use of the navigational aids at their disposal was made by the Pilots of the "Saint Kevin" on their last flight. Apparently they were satisfied that they knew where they were although in fact they were somewhere else. It is therefore difficult to relate to the experience of this Inquiry a strongly-urged suggestion that aircraft of this type on this route should carry an additional member of the crew in the person of a Radio Officer who would ensure that use could be made of the Gee radio navigational device at times when the two pilots were constrained to remain in their seats. There is no evidence that the Captain of the "Saint Kevin" took any step to obtain a Gee fix, or that he wished to do so but could not because neither he nor his 1st Officer could leave his seat to go to the apparatus. The Court is not disposed to make any recommendation expressed in terms of the use or non-use of this device. Other suggestions directed to the more accurate ascertainment of position follow later in this Report.

66. *The Practice in Connection with Maintenance Inspections.*

It emerged in the course of the Inquiry that whereas only duly licensed inspecting aircraft engineers for airframe and engines respectively are entitled to sign the documents which testify to certain prescribed checks having been completed, in many cases in fact such checks are carried out by engineers who are not licensed. Such unlicensed engineers report their completion of the prescribed check to the licensed inspector who thereupon signs the document without himself having made any examination of the aircraft.

The licensed engineer of course assumes responsibility for the work of his subordinate and no doubt would be unwilling to do so unless he were abundantly satisfied of his competence and trustworthiness. At the same time it appears to the Court to be a bad thing, if only from the point of view of "public relations," that it should come to be felt that a system which requires the intervention of a qualified and duly licensed person should be held to be satisfied by no more than the signature of such a person. The foregoing implies no shadow of suspicion that any error or default in connection with such matters occurred in this case.

67. *The Sufficiency of Navigational Aids*

It is of course obvious that there must be limits to the provision of costly devices such as radio ranges, fan markers and radio beacons. Not every route can be turned into an "airway." Risk of confusion as well as lack of money and free frequencies would preclude such a solution to the problems of navigators. At the same time it must be realised that the air traffic between England and Eire is important and growing and that the shortest route between London and Dublin passes over a difficult mountainous terrain and close to Snowdon. In the view of the Court consideration should be given to the practicability of giving pilots a better lead over the part of the route which lies between 3° W. and Nevin Beacon. Although use can be made of some or all of the aids referred to in paragraph 29 above there is between Daventry and Nevin no specifically located navigational aid. It is perhaps a fair inference from the few facts established in this Inquiry that in practice pilots tend to be content to do without recourse to aids which "take up time on the air" especially when such aids may be suspected of giving no greater accuracy on a short route or stage of a route than does dead reckoning. It is for consideration whether on this route a specifically located aid in the form perhaps of an intermediate radio beacon ought to be provided.

68. *Detection of Icing in Darkness*

It emerged in the course of the Inquiry that on DC-3 aircraft no light is fitted by which the parts of the airframe liable to receive a build-up of icing can be seen from the cockpit. Pilots must either use a hand torch or resort to switching the

landing lights on and off and observing the amount of the build-up on the glass of the lights in the dying glow. Neither of these methods can be regarded as satisfactory. In certain DC-3 aircraft adapted for service on commercial air lines a special light is fitted so as to illumine the leading edges of the wings and this might well be made a standard practice for all aircraft.

69. *The Importance of " de-briefing "*

The meteorological service provided for the benefit of aviators is like any other intelligence service dependent upon the reading of data obtained from a large variety of sources. One of the most valuable sources is the experience of persons having just come in from a flight on the same route. This giving of information by pilots to the meteorological officers is known as " de-briefing " and it is the opinion of the Court that pilots should be encouraged to attend at the " Met. Office " for " de-briefing " within some specified period (say 30 minutes) of landing from any flight under instrument flight rules or where any unexpected weather phenomenon has been experienced.

Part X

RECOMMENDATIONS

70. The safety height for stages of an air route which cross mountain ranges should be related to meteorological as well as to orographical data. This means that on occasions when the meteorological forecast indicates that strong winds will be encountered at the approaches to and over the range the safety height (which is usually 1,000 feet above the contours) should be increased and so shown on the flight plan. The following clearances are provisionally suggested for flights under IFR pending the results of the investigation proposed in paragraph 71 below :—

Wind speed at height of crest	*Clearance*
26-35 knots	2,000 feet
36-45 ,,	2,500 ,,
46-55 ,,	3,000 ,,
56-65 ,,	4,000 ,,

It is recognised that such clearances might on some occasions force an aircraft above the freezing level and that with slow-climbing aircraft the duration of a flight on a short route might be unduly prolonged. Such matters would have to be brought into calculation before any mandatory regulations could be made.

71. Investigations should be made of the vertical currents in airstreams of high velocity and differing degrees of stability crossing mountain ranges so that the resulting data may be applied to the establishment of safety heights on regular air routes crossing such ranges.

72. An investigation should be made of the reduction in the height of the freezing level in a stable airstream crossing a mountain range and meteorological officers should indicate the allowance, based on the investigation, in their forecasts and briefing.

73. An investigation should be made of the effect of turbulence over the land in changing a thermally stable airstream towards a labile state in order to determine the resulting change in the height of the freezing level when this lies within the layer affected.

74. Consideration should be given to the desirability of making more frequent radio-sonde observations at one or more of the stations in key positions when the meteorological situation is changing exceptionally rapidly.

75. Consideration should be given to the desirability of discontinuing the use of a percentage tolerance in the forecast height of the freezing level. It is probable that the lay-out of the conventional form for route forecasts is in itself an invitation to forecasters to be less explicit than they might be about the limits between which the freezing level is expected to lie. In the opinion of the Court those limits should be explicitly stated.

76. Air crews should be provided with the corrections necessary to obtain the true air temperature from the reading of the thermometer on the aircraft. They should also receive instruction as to the significance of " wet-bulb " temperature in relation to freezing and melting.

77. Consideration should be given to improving the system of collaboration between the Air Ministry (Meteorological Office), the Ministry of Civil Aviation (Air Traffic Control) and Operators of Civil Aircraft whereby it can be ensured that substantial actual or imminent changes in the meteorological conditions along an air route are notified by controllers to aircraft on the route.

78. The framers of schedules and those responsible for rostering pilots as well as the pilots themselves should always keep in mind the importance of allowing sufficient time at airports to permit direct personal briefing of pilots by meteorological officers. The location of the meteorological office may be an influence in encouraging or discouraging pilots to or from

making a personal visit to the forecaster, and a too rapid " turn-round " may be a real discouragement. The value of direct personal briefing in marginal weather conditions is too great to be sacrificed to the other concerns which may engage the attention of pilots during quick " turn-rounds."

79. Consideration should be given to devising a discipline which will minimise the risk of moveable objects, e.g. computers, Verey pistol, articles of clothing and crews' effects getting adrift in the cockpit in turbulent conditions. Articles of this kind unless properly stowed may easily slip down into the mechanism of the control system and lead to the jamming of controls. It may be that the provision of better stowage facilities ought to precede the formulation of disciplinary rules.

80. Careful thought should be given to the question whether or not pilots are actually encouraged to rely too much upon dead reckoning through the absence of sufficiently strict instructions from their employers on the subject of entries in the aircraft navigational log. The Court leans to the view that it might lead to better all round navigation if it were made mandatory upon Captains to record in the log a definite " fix " of position every so many (depending upon the length and/or nature of the route) minutes of flight with an annotation showing the method used to obtain such "fix." It is further for consideration whether such " fixes " ought to be reported by R/T to the appropriate FIR when a fix shows that the aircraft is materially off course: such consideration will of course have due regard to the importance of securing a prudent economy in the use of busy communication channels.

81. Consideration should be given to the question of providing a specifically located aid to navigation between Daventry and Nevin.

82. Study should be given to the problem of designing a means whereby the build-up of icing can be watched during darkness. It is for consideration whether the provision of such means ought to be made compulsory and its continuous use in icing conditions be prescribed in the disciplinary code of operators.

QUESTIONS AND ANSWERS

The Court's answers to the questions submitted by the Attorney-General are as follows:—

(1) Did the aircraft have a valid Certificate of Airworthiness and did it have a current Certificate of Safety at the commencement of the flight from Northolt on 10th January, 1952 ?

Yes.

(2) Was the aircraft loaded and trimmed within the specified limits set out in the Certificate of Airworthiness ?

Yes.

(3) Did the aircraft depart from Northolt with sufficient fuel and oil for the proposed flight ?

Yes.

(4) Did the aircraft carry sufficient crew; were they qualified and were they adequately experienced to undertake the flight ?

Save that First Officer [redacted] did not hold a Radio/Telephony Licence—Yes.

(5) Was the Captain's decision to operate the service to Dublin via Daventry and Nevin a correct one ?

Yes.

(6) Did the Captain encounter weather conditions materially different from those he might reasonably have expected ?

No.

(6A) Was the Captain furnished with all pertinent meteorological information during the flight ?

The Captain was not furnished with any meteorological information during the flight. No pertinent information which under the existing regulations ought to have been passed to the Captain in flight was withheld.

(7) In what respects, if any, was the navigation of the aircraft unsatisfactory ?

The navigation of the aircraft was unsatisfactory in that it took the aircraft to a position close under the lee of Snowdon at a time when the Captain believed that he was coming out over the Irish Sea.

(8) Were the means for the prevention or removal of ice fitted to this aircraft adequate for the flight ?

Yes.

(9) Did the failure of any part of the aircraft or its equipment cause or contribute to the loss of the aircraft ?

The condition of the wreckage precludes a definite answer, but on the evidence available—No.

(10) What was the probable cause of the loss of the aircraft?

The encountering of a powerful down-current of air on the lee side of Snowdon which forced the aircraft down into an area of very great turbulence where through one or another of several possible causes the pilot or pilots lost control.

(11) Was the loss of the aircraft caused or contributed to by the wrongful act or default of any person or party?

No.

(Signed) [redacted]

31st JULY, 1952

APPENDIX I

LIST OF WITNESSES

[redacted] Police Sergeant, Caernarvonshire Constabulary.

[redacted], Resident of Nantgwynant, Caernarvonshire.

[redacted] Resident of Dolwyddelan, Caernarvonshire.

[redacted] Mechanic, Aer Lingus, Northolt Airport.

[redacted] Station Engineer, Aer Lingus, Northolt Airport.

[redacted] Chief Investigating Officer, Accidents Investigation Branch, Ministry of Civil Aviation.

[redacted] Chargehand Ground Engineer, Aer Lingus, Northolt Airport.

[redacted] Station Officer, Aer Lingus, Northolt Airport.

[redacted] Captain, Aer Lingus.

[redacted] First Officer, Aer Lingus.

[redacted] Clerk, B.E.A., Northolt Airport.

[redacted] Inspector of Engines, Aer Lingus, Dublin Airport.

[redacted] Air Traffic Control Officer III, Ministry of Civil Aviation, Preston.

[redacted] Air Traffic Control Officer II, Ministry of Civil Aviation, Preston.

[redacted] Operations Officer, Ministry of Civil Aviation.

[redacted] Air Traffic Control Officer III, Dublin Air Traffic Control Centre.

[redacted] Senior Air Traffic Controller, Dublin Airport.

[redacted] Captain, Aer Lingus.

RAPHAEL MICHAEL GREENE, Captain, Aer Lingus.

[redacted] Senior Experimental Officer, Meteorological Office.

[redacted] Experimental Officer, Meteorological Office.

[redacted] Senior Meteorological Officer, Northolt Airport.

[redacted] Deputy Director, Meteorological Office.

[redacted] Radio Officer, Ministry of Civil Aviation.

[redacted] First Officer, Aer Lingus.

[redacted] Captain B.E.A., Dart Development Unit.

[redacted] Senior Experimental Officer, Meteorological Office.

[redacted] Meteorological Officer, Dublin Airport.

[redacted] Operations Officer, Ministry of Civil Aviation.

[redacted] Aeronautical Inspector, Department of Industry, Eire.

[redacted] Communications Controller, Aer Lingus, Dublin Airport.

[redacted] Captain, Aer Lingus.

[redacted] Operations Manager, Aer Lingus, Dublin Airport.

[redacted] First Officer, B.E.A.

[redacted] Air Traffic Control Officer III, Ministry of Civil Aviation.

[redacted] Chief Engineer, Aer Lingus, Dublin.

[redacted] Engineering Inspector, B.E.A., Northolt and London Airport.

[redacted] Assistant Secretary and Legal Adviser, Aer Lingus, Dublin.

[redacted] Resident, Llanberis, Caernarvonshire, Mountain Rescue Unit.

[redacted] Captain, Aer Lingus.

Appendix II

LIST OF REPRESENTATIONS

Mr. [redacted] and Mr. [redacted] (instructed by the Treasury Solicitor) appeared on behalf of the Attorney-General.

Mr. [redacted] (instructed by Messrs. Beaumont & Son) appeared on behalf of Aer Lingus.

The Hon. [redacted] (instructed by Messrs. Silkin & Silkin) appeared on behalf of the relatives of Captain [redacted] decd., and Mr. [redacted] decd.; (instructed by Messrs. Frere, Cholmeley & Nicholsons) appeared on behalf of the relatives of Mr. [redacted] decd.; (instructed by Messrs. McKeever & Sons) appeared on behalf of the relatives of Mr. [redacted] decd.

Mr. [redacted] (instructed by Messrs. Shaen, Roscoe & Co.) appeared on behalf of the Radio Officers Union.

Mr. [redacted] (instructed by Messrs. J. H. Kidgell & Co.) appeared on behalf of the Workers Union of Ireland and the Irish Air Lines Pilots' Association, and on behalf of Mrs. [redacted]

Mr. [redacted] (Chief Aeronautical, Officer, Department of Industry and Commerce, Ireland) appeared on behalf of the Irish Government.

Appendix III

The Court sat at Holborn Town Hall as follows :

17th April, 1952.
18th ,, ,,
21st ,, ,,
22nd ,, ,,
23rd ,, ,,
24th ,, ,,
25th ,, ,,
28th ,, ,,
29th ,, ,,
16th May, ,,

After the close of the Public Hearing the Court and Assessors met on nine separate occasions for the purpose of writing the Report.